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CATECHOL TEST FOR FROZEN FRUITS

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Catechol Test For Frozen Fruits

By J. D. PONTING*

Darkening of fruits has long been a source of annoyance to many frozen fruit packers. In an attempt to aid the industry, the Western Regional Research Laboratory has done considerable research, the results of which we take pride in presenting herewith in a study entitled, "Catechol Test Measures Activity of Enzymes That Cause Browning in Frozen Fruits," by J. D. Ponting. We feel that this article is of great value to every frozen food packer.

Fruits that discolor readily, such as apples, apricots and peaches, require pretreatment with a scald, sulfur dioxide or other treatment, before they are frozen, as a means of inactivating the enzymes that cause discoloration. Reduction of enzyme activity controls darkening of the fruit flesh before freezing, during frozen storage and after the fruit is defrosted.

During pretreatment it is of value to be able to test for extent of inactivation of enzymes in the pieces of fruit. A simple test, developed in the course of research on freezing preservation of fruits in this Laboratory, has proved successful and convenient. It requires little time, only one reagent and no special apparatus. Its reliability has been proved by experiment.

Simple, Rapid Test

The principle of this test is simple. The pure chemical catechol is very similar to the natural fruit substances that darken by oxidation, being in fact one of the most important components of the natural darkening material. Natural discoloration is slow because the amount of such material in the fruit is small; addition of catechol greatly increases the rate of darkening, reducing the time required to reach a brown or black color from several hours to a few minutes. The catechol darkens rapidly only in the presence of oxidizing enzymes, the blackened areas thereby indicating the location of active enzymes.

The catechol test as applied to pie fruits is as follows: Each of several pieces of fruit, especially the larger ones, is cut in two after treatment. An approximately 1-per cent solution of catechol in water is then spread on the cut surface, a medicine dropper being a convenient dispenser. After a few minutes the portion of the fruit still containing active enzymes will turn black, but wherever the enzymes have been inactivated the fruit will retain its natural color. The dark color usually appears in 5 to 10 minutes; the test may be considered negative if no dark color appears in 20 minutes.

Catechol can be obtained from chemical supply houses. It is a white crystalline compound, very soluble in water. In solution it gradually turns brown as a result of oxidation, but this darkening does not affect the enzyme test appreciably.

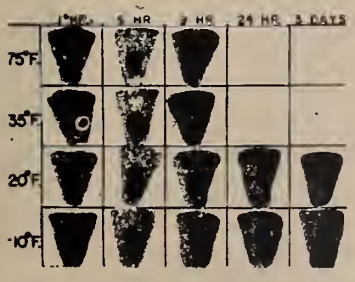

Figure 1: Rate of penetration of SO_2 into slices after dipping in sodium bisulfite solution. (4000 p.p.m. SO_2, 5 min. dip).

The accompanying photographs (Figs 1 and 2) show some applications of the catechol test. Figure 1 illustrates a problem that arose in the industry. Apple slices were dipped in a sodium bisulfite solution and then frozen without delay. Some of these apples were rejected by brokers because of brown centers. Experiment showed that when apples were stored at −10° F. immediately after dipping, the sodium bisulfite penetrated until the apples were solidly frozen, when penetration ceased. Such apples eventually develop brown centers during frozen storage. In using a sodium bisulfite treatment it is therefore necessary to hold the apples after dipping and before freezing until penetration is complete.

Figures 1 and 2 illustrate the rates of penetration into apples of SO_2 in the forms of sodium bisulfite and sulfurous acid. Although it does not appear to be generally known, there is a great difference in the rate of penetration of SO_2 as sulfurous acid (a solution of SO_2 gas in water) and as sodium bisulfite, even though each has the same SO_2 content. Thus, it may be seen from Figure 1 that at 75° F. about 9 hours is required for the SO_2 in a sodium bisulfite solution to penetrate to the center of apple segments (twelfths); on the other hand, Figure 2 shows that SO_2 in a sulfurous acid solution penetrates in less than 1 hour, even at 20° F. The difference in rate no doubt depends on the acidity of the solutions.

May Be Used On All Fruits

The catechol test is effective with all the common fruits being frozen in pieces, since all contain the same type of oxidizing enzyme systems. However, the applicability of the test in determining effectiveness of treatments before freezing varies considerably from fruit to fruit. In SO_2-treated apples the test can be used to show the extent of penetration; when penetration is complete the fruit is ready to be frozen. If penetration is not complete, brown centers will develop during freezing or when the fruit is defrosted. In the case of apricots, which cannot be penetrated readily by solutions or gases, it is not necessary that the fruit be completely penetrated by sulfurous acid or bisulfite solution before it is frozen. No browning occurs in the unpenetrated centers during freezing or thawing, apparently because atmospheric oxygen, like sulfur dioxide, cannot readily penetrate the fruit. For apricots it is only necessary to penetrate the surface slightly with SO_2, and in this case the catechol test is of little use. Peaches are similar to apricots in their SO_2-penetration characteristics.

The catechol test is generally applicable in determining the effectiveness of scalding treatments (with steam or hot water), since in this case the enzyme usually must be completely inactivated before the fruit is frozen to prevent browning when it is defrosted. The test is also useful in comparing the effectiveness of various treatments for the inactivation of oxidizing enzymes in fruits. Use of this test has shown that scalding and treating with SO_2 are the most effective of many treatments tested in this Laboratory.

The test measures the activity of the oxidizing enzymes in fruits but not necessarily the tendency of the fruit to darken naturally. Darkening requires both oxidizing enzyme and a substance capable of being oxidized by the enzyme to a dark-colored product. If a fruit contains only a small amount of either enzyme or darkening substance, the natural browning will be correspondingly slow. For example, the Sunbeam peach does not darken naturally because it contains practically no substance capable of darkening upon oxidation, although it does contain active oxidizing enzymes.

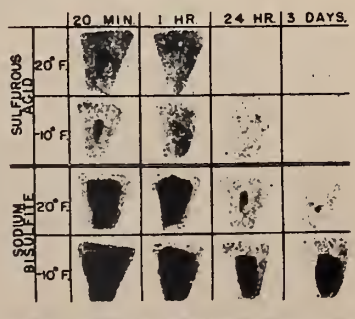

Figure 2: Rates of penetration of SO_2 into apple slices from sulfurous acid and sodium bisulfite solutions. (4000 p.p.m. SO_2, 5 min. dip).

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